PCT / SE 2004 / 001438

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PATENT- OCH REGISTRERINGSVERKET

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(21) Patentansökningsnummer Patent application number — *0302685-3*

(86) Ingivningsdatum Date of filing — *2003-10-07*

Stockholm, 2004-10-12

För Patent- och registreringsverket
For the Patent- and Registration Office

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Avgift
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Method and arrangement in a telecommunication system

FIELD OF THE INVENTION

The present invention relates to a method and system in a 3rd generation mobile communication system, in particular to an RLC aware Node B scheduler.

BACKGROUND OF THE INVENTION

For release 5, the WCDMA specification is extended with a new downlink transport channel, the High Speed Downlink Shared Channel (HS-DSCH). HS-DSCH provides enhanced support for interactive, background, and, to some extent, streaming radio-access-bearer (RAB) services in the downlink direction. More specifically, compared to release 99/4, HS-DSCH allows for higher capacity, reduced delay and significantly higher peak data rates

HS-DSCH transmission is based on Shared-Channel transmission, similar to release 99/4 Downlink Shared Channel (DSCH). However, HS-DSCH transmission supports several new features, not supported for DSCH:

HS-DSCH supports the use of higher-order modulation. This allows for higher peak data rates and higher capacity.

HS-DSCH supports fast link adaptation and fast channel-dependent scheduling. This means that the instantaneous radio-channel conditions can be taken into account in the selection of transmission parameters as well as in the scheduling decision and allows for higher capacity.

HS-DSCH supports fast Hybrid ARQ with soft combining. This reduces the number of retransmissions as well as the time between retransmissions and allows for higher capacity and a substantial reduction in delay. The use of Hybrid ARQ with soft combining also adds robustness to the link adaptation.

To support these features with minimum impact on the existing radio-interface protocol architecture, a new MAC sub-layer, MAC-hs, is introduced for HS-DSCH transmission. To reduce the retransmission delay for Hybrid ARQ and allow for as up-to-date channel-quality estimates as possible for the link adaptation and channel-dependent scheduling, MAC-hs is located in the Node B. For the same reasons, HS-DSCH uses a shorter TTI (2 ms) compared to release 99/4 transport channels.

RLC is typically operated in AM mode when used with HS-DSCH, implying that retransmissions are performed between the RNC and the UE. Retransmissions on MAC-hs level is also performed between the Node B and the UE for downlink data traffic. The MAC-hs retransmissions imply that RLC experience an almost error free link.

Since a Node B serves a large number of users, data to a particular UE may need to be buffered in the Node B until it can be transmitted. A UE can use several radio bearers with different priority which can also cause data for a low priority to be buffered a significant time if higher priority data is available for transmission.

In HSDPA, scheduling decisions are made at the Node-B. This means that the Node-B has to buffer data before the transmission can take place. The amount of data that is stored can be negotiated with the RNC using a credit scheme (see 25.877). Of course, there is a certain delay associated

with this negotiation procedure. The Node-B needs to send a capacity allocation message, this has to be processed by the RNC and the associated data sent down. In the following this delay will be referred to as the credit round-trip-time (cRTT).

At any one time, the Node-B needs to store for each UE enough data to satisfy all its transmissions that can take place during such a cRTT. Of course, it would also be possible to simply keep enough data across all the UEs in the cell, but this would lead to sub-optimal scheduling decisions, as the decisions would be driven by data availability rather than channel conditions. Memory allowing, the best over-the-air performance would therefore be achieved if the Node-B gave out enough credits for all the data sitting at the RNC.

RLC AM relies on retransmissions to achieve the desired residual frame error rate. Re-transmissions are triggered by sending feedback information on the status of each packet. The amount of buffer required in order to avoid stalling is proportional to the over-the-air throughput and to the re-transmission round-trip-time (rRTT). The rRTT is the time between the moment when the hole (in the sequence numbers) is detected by the receiver and the time the packet is transmitted again over the air. Therefore, there is an incentive to reduce the rRTT as a means of either reducing the RLC buffer requirements at the mobile, or to improve RLC performance at equal RLC buffer size.

Currently, the Frame protocol does not identify the type of RLC packet being sent down. This means that in addition to the status report transmission delay, the rRTT will also include buffering delays at the Node-B. Therefore, the

larger the amount of data sitting in the Node-B buffer is, the larger the rRTT will be.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the format of AMD (data) PDUs.

Figure 2 shows the format of an AM STATUS PDU

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to the problem that the buffering in Node B introduces a delay that affects the round trip time (RTT) of the RLC and negatively impacts the RLC performance in terms of SDU delay and throughput.

One way to decrease the RTT could be to introduce different priorities for different types of RLC PDUs. For example status PDUs and retransmitted PDUs can be given high priority and PDUs transmitted for the first time can be given lower priority.

For uplink traffic, the performance could be improved if the RLC status PDUs (ARQ feedback information transmitted in the downlink direction) could be transmitted as quickly as possible in the Node B.

For downlink traffic retransmitted PDUs could be prioritised over PDUs transmitted for the first time which would lead to that data in the UE can be delivered faster to higher layers. AM RLC uses in-order delivery which means that data is delivered in the same order it was transmitted from the RNC RLC entity. If an RLC PDU is missing, all PDUs with

higher sequence numbers are buffered until the missing PDU is received. Thus a missing PDU causes delay for all subsequent data and it could therefore improve performance by assuring that the missing PDUs, i.e. retransmissions, are prioritised.

It has been proposed to signal the priority levels for different types of RLC PDUs on the Iub interface as part of the frame handling protocol. The idea is to use a 2 bit field indicating the priority between RNC and Node B.

According to the present invention it is proposed that, instead of relying on priority levels signaled from RNC to Node B, the Node B can make an autonomous classification of RLC PDUs based on the content in the RLC PDU header.

Node B does normally not contain RLC functionality, but a simplified RLC layer could be implemented which only checks the first two octets of each RLC PDU, i.e. the AM RLC header. The AM RLC PDU format is shown in the figure below. More details of the RLC layer can be found in the Technical Specification 3GPP TS25.322 "Radio Link Control Protocol Specification" by the 3rd Generation Partnership Project.

The D/C field indicates whether the RLC PDU is an AMD PDU (data PDU) or a control PDU. For control PDUs, the PDU type field indicates if the PDU is a STATUS PDU, a RESET PDU or a RESET ACK PDU.

After identifying the RLC PDU type, a prioritization is made based on the PDU type. Further, for data PDUs, an identification of retransmitted PDUs can be made based on the sequence numbers of the PDU, where the highest received sequence number is stored and all PDUs with lower sequence numbers are considered to be retransmissions. Note that in

this decision the modulo nature of the sequence numbers need to be considered.

In the Node B scheduler, PDUs that are given high priority is transmitted before the PDUs with lower priority, and thus achieving a lower average delay for the high priority PDUs.

For example all status PDUs can be given higher priority than data PDUs which would improve the performance of uplink data traffic. In addition, retransmitted PDUs can be given higher priority than PDUs transmitted for the first time. Finally, data PDUs with the poll bit set to one could be prioritized over other data PDUs.

If the Node B is RLC aware, it can also perform a number of other performance enhancing functions:

1) If the same RLC PDU is present more than once in the buffer (due to RLC level retransmissions), the Node B removes the duplicate PDUs and only transmits the first instance of the PDU.

2) If the polling bit is set in an RLC PDU in the buffer, the Node B can modify the header of another RLC PDU (preferable located earlier in the buffer) and set the poll bit in that RLC PDU instead and potentially remove the poll bit from the first PDU, thus reducing the time until the poll is received in the UE.

The method according to the present invention achieves thus a reduced RLC round trip time for selected RLC PDUs leading to improved performance in terms of SDU delay and throughput. The method does not rely on any signaling from the RNC to Node B and can be implemented with current 3GPP

REL-5 specifications. While the state of the art is based on explicit signaling between RNC and Node B, the present invention achieves the same object but without relying on explicit signaling.

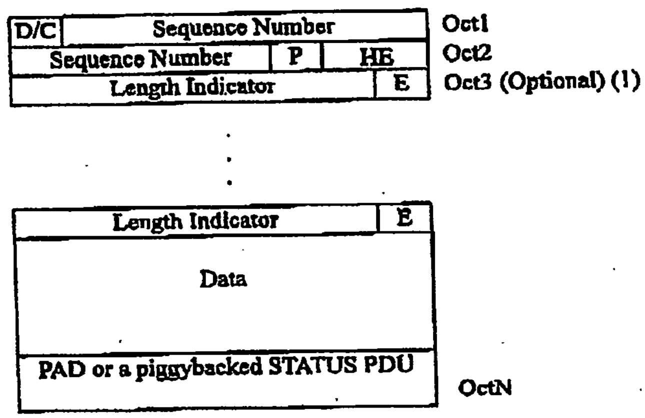

Figure 1

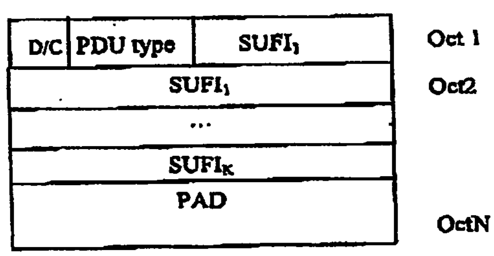

Figure 2